

PROJECT	GENERAL BUSINESS		
TITLE	Coating and Colour		
DOC. NO.	W0102-Q06-001-SPEC-304-W2E-001-7-EN	VERSION	7
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Change Record

Version	Date	Change Description
1	29.01.2007	First issue
2	11.08.2011	Chapter 2 and Chapter 3.3 changed Changes in red
3	30.09.2011	3 rd issue, new title
4	08.03.2012	See chapter 3.6 Corrosion-proofing
5	22.01.2014	Divers identifiers of products from Fa. Hempel (Germany) GmbH updated, see changes in red colour
6	22.01.2014	Not released
7	02.03.2018	Extension of the corrosion protection for metallic clean surfaces

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1. General

This Specification covers a general description of the nature of coatings in a WTS they are required. The Specification includes all required data which enable the supplier to deliver the component in way requested by the buyer. A Purchaser Technical Specification (PTSP) isn't scheduled. The supplier is subject to the duty carefully to check all data of the Specification. Critical notes or lack of details have to be informed to the buyer.

1.1 Scope

For the several materials and position of plan components are defined coating systems. The data applying for the components are respectively valid it. In the individual case the details have to be taken into drawing or datasheet of the component or the PTSP of systems, particularly these areas, they not coating and so they must be cover.

Additionally the specification is describing coating systems for hot dip galvanized parts, for stainless steel, for metallized areas.

Coating systems for plastics and/or synthetic materials are not object of this specification. As far as not otherwise agreed, the content of this specification are regulated by contract differently, then are all other contents of the specification valid and must be applied.

1.2 Responsibilities

Pre- treatment and coatings are to complete by the component supplier or in his responsibility by a varnishes. The component supplier must ensure the compliance of the required dry film thicknesses as well as the pre- treatment.

1.3 Quality documentation

3 All corrosion protection works must be documented. Absolutely necessary are:

- Batch number of all applied paints.
- Air- and surface temperature, relative humidity and dew point for all operations, including surface preparation.
- Blasting abrasive and supplier.
- Start and end time of blast cleaning and of all single paint applications.
- Surface cleanliness and roughness after blast cleaning.
- If a shopprimer is used, type, name and supplier of the shopprimer.
- Wet- and dry film thickness of every applied paint layer.
- Used measurement equipment and last certification date (duration of validity).

It is recommended to use the forms of the DIN EN ISO 12944, part 8.

For the documentation of the dry film thickness is required a proof with a measure device. A photo of rust removal and the expertise of severally person are recommended.

The supplier must attach every component the final report over the corrosion protect according EN ISO 12944-8:1988 Affix J.

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1.4 Curing

Every coating must be curing adequate before the following coating carried out. For delivery of the component must the coating system cured so that disadvantages thought transportation will beware.

1.5 Tinge of topcoat

The tinge of topcoat is to see in the specification and datasheets or drawings of the components.

Standard in use:

RAL 7035 for outside- and inside machine parts how tubular tower, machine frame, all bearings, hub, housing parts as soon as transformer and cabinets.

RAL 5023 for inside components how main shaft coupling, main gear box, gears, coupling and generator.

1.6 Applied Norms and standards

For the execution of the corrosion protection works are the documentation of part 5 valid.

Valid are always the latest issues of all norms and standards to be used. Are more than one norm / standard valid for a technical matter / case, then the strictest interpretation must be applied.

1.7 Responsibility of the contractor

This specification has to be checked by the supplier regarding the technical content. If the supplier is finding any wrong or unclear or inadequate contents affecting his work, then the contractor must inform his client in written form. This is also valid for contradictions of this specification with the contents of norms and standards to be used. Any deviations from this specification need the written approval of the client.

1.8 Quality assurance

Companies, carrying out corrosion protection works must have skilled staff and equipment, which enable them to do the works according to the standard in a safe and reliable way. The corrosion protection works have to be supervised permanently by authorised staff of the supplier (in workshops and on site). This staff should be qualified. Supervision has to be done with the necessary and suitable equipment.

Reference areas (KF) according to DIN EN ISO 12944, part 7 and 8 have to be made on every production site for main structures like towers and foundations otherwise according to the determining of the purchaser. Number, location and marking of the reference areas should be agreed beforehand. Otherwise the recommendations of the DIN EN ISO 12944, part 7 have to be applied. Reference areas have to be planned as early as possible to make sure that all involved parties have the same knowledge about the demanded quality requirements. The contractor shall invite early in advance the purchaser and the paint supplier (min. 5 working days beforehand). Reference areas have to be made also, when the purchaser does not participate. The paint supplier has to send a qualified person. It is recommended to involve the paint supplier in relevant meetings and in supervision from the beginning.

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1.9 Warranty

The supplier warranted for his delivery and service free of failings. The warranty for the corrosion protection is 5 years, starting with the doing of the reference areas, when not otherwise agreed. At the end of warranty, the degree of derusting according to DIN EN ISO 4628, part 3 must not exceed R1. Cracking, blistering and flaking must not occur (valid also for the single layer of the coating system). By a deviation for the defined coating systems must this reported. A release from W2E or the seller is necessary to perform.

Warranty has to be agreed in written form between the partners.

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2. Coating material supplier

For the coating compound are following suppliers accepted:

1. Hempel (Germany) GmbH
2. Strathmore Products, Inc.

If you have any questions concerning pre- treatment and coating system please contact the paint supplier directly.

The following listed varnish types and dry film thicknesses refer to the products of the above listed company Hempel (Germany) GmbH. Before coating compound other supplier used, it is to document, that they are in an equal quality. Dry film thicknesses and material selection are adequate to align.

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3. Coating systems

3.1 General remarks

Only approved coating systems are allowed to be used. For tubular tower and foundation structures as well as other components do not use / do not mix coating systems of different suppliers for one (coherent) structure.

According to DIN EN ISO 12944, part 5, clause 5.5, the durability of the coating system for WTG is > 15 years. The coating system must correspond to corrosivity category C5 – industry (outside exposure) and C3 (inside exposure) for onshore erection and the corrosivity category C5 – marine (outside exposure) and C4 (inside exposure) for offshore-use.

3.1.1 Shopprimer

The use of shopprimer is subject of approval by the purchaser. Shopprimers can only be used if they are suited for the use in corrosivity category C5- marine according to DIN EN ISO 12944, part 5, table B.2 and if the shopprimers are compatible with the coating systems mentioned under chapter 3 of this specification. That has to be confirmed in written form. If at all only zinc- silicate or zinc- epoxy shopprimer should be used.

3.1.2 Dry film thicknesses

Please note that in contrast to the DIN EN ISO 12944, part 5, clause 5.4 all mentioned dry film thickness of coating systems are minimum thicknesses. It is not allowed to fall below. The readings of the single layers of a coating system may deviate to below up to 20% in thickness. The maximum total dry film thickness of any coating system must not exceed the double of the specified thickness.

3.1.3 Gloss of top coat

The last paint layer (top coat) has to be applied in a way that an uniform and even appearance is resulting. The gloss has to be 40 – 60 units, measured with an angle of 60° according to DIN 67530. The differences in gloss should not exceed 15 units within large coherent areas (e.g. tower section).

Every coating supplier has to provide a repair specification.

3.2 Painting

The relevant product datasheet of paint suppliers have to be followed. Any deviation is subject of written approval. All paint works have to be documented (see DIN EN ISO 12944, part 8, page 16 – 17). This documentation is part of supply.

Immediately after surface preparation the first coat (primer) must be applied. The primer must be applied either by (airless) spray or by brush. Roller application is not allowed (see DIN EN ISO 12944, part 7, chapter 5.3.2).

All edges and welding seams must get at least one stripe coat before spray application. The stripe coat can be applied by airless spray onto edges but only with brush onto welding seams. Furthermore, all areas difficult to access for airless spray must get a stripe coat before.

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Paints must be applied only, when the temperature of the surface to be painted, is at least 5°C and min. 3°C above their dew point (DIN EN ISO 8502-4). The relative humidity must not exceed 80%. At surface temperature above 35°C consult the paint supplier before paint application.

All paint works have to be separated spatially from any other operations to avoid any contamination. Freshly painted areas have to be protected. Application mistakes like overspray, pinholes, holidays and saggings are not allowed. The last top coat must applied in the (RAL) coloring how ordered.

3.3 Coating systems for tubular towers and rotor hubs

Feature	Description	Value
Surface preparation		
<ul style="list-style-type: none"> All mechanical treatment (e.g. welding, cutting, grinding, bending etc.) must be finished before any surface preparation startet. Cast iron has to be of good quality and without cavities. It may not gasses any more. Welding beads / splatters, welding slag, welding pores and laminations must be removed. Edges must have a radius of 2 mm. Welding seams must be prepared in a way that the specified coating thickness can be safely applied. DIN EN ISO 12944, part 3, page 11, picture D.5 and D.6 (category good) as well as ISO 8501, part 3, preparation grade P2 (onshore) and P3 (offshore) must be considered. Oil and Grease etc. must be removed by suitable agents. Salts, dirt and other adhesion-hindering contaminants must be removed by high pressure water cleaning or other suitable agents. Abrasive blast cleaning until min. Sa 2,5 according to DIN EN ISO 8501, part 1 with a sharp-edged abrasive. Surface roughness according to Rugotest no. 3, BN9a, Keane-Tator Comparator, 2.0 G/S, 2 S, or ISO Comparator, Medium (G). Carefully blasting abrasive removed and dedusting. 		
Coating System for onshore, C5- industry long (outside atmosphere)		
It concerns tubular tower, rotor hub, machine frame as well as any steel- and cast parts		
		Dry film thickness in [µm]
Priming coat	Epoxy zinc dust primer HEMPADUR 17360	50
Intermediate coat	Epoxy intermediate coat HEMPADUR 47300 / 47140 / 45880/W	140
Top coat	Polyurethane-topcoat HEMPATHANE 55610 / 55210/4	50
Total	Minimum dry film thickness:	240
Feature	Description	Value
It concerns tubular tower inside as well as any steel- and cast parts located inside the nacelle how main gear box, yaw drive units, generator i.a.,C3 long)		
		Dry film thickness in [µm]

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Priming coat	Epoxy primer or Pur-Hempadur PUR-HEMPADUR 47300 / 47200 / 47140 / 45880/W	150
Top coat	Polyurethane-topcoat HEMPATHANE 55610 / 55210/4	50
Total	Minimum dry film thickness:	200
It concerns steel parts with finish surface $R_a \leq 6.3 \mu\text{m}$ ($R_z \leq 60 \mu\text{m}$), e.g. rotor coupling		
<u>Surface preparation</u>		
<ul style="list-style-type: none"> Alkaline cleaning, flushing with water (better water steam) or carefully cleaning with adequate dissolver (cleaning cloth only once used, the dissolver not contaminate with dirty cleaning cloth). Bevelling with 80 grain paper or bevelling fleece (Scotch brite), adjacent carefully dedusting. The first priming coat is via brush to coat strong in the rib profile. 		
		Dry film thickness in [μm]
Priming coat	Tectyl 506-EH	50
Top coat		
Total	Minimum dry film thickness:	50
It concerns steel parts with finish surface $R_a > 6.3 \mu\text{m}$ till $R_a \leq 12.5$ ($R_z > 60 \mu\text{m}$ till $R_z \leq 100 \mu\text{m}$), e.g. rotor coupling		
		Dry film thickness in [μm]
Priming coat	Epoxy zinc dust primer HEMPADUR 17360	50
Top coat		
Total	Minimum dry film thickness:	50
Feature	Description	Value
Coating System for offshore, C5- marine long (outside atmosphere)		
It concerns tubular tower out side, rotor hub, machine frame as well as any steel- and cast parts		
		Dry film thickness in [μm]

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Priming coat	Epoxy zinc dust primer HEMPADUR 17380	60
Intermediate coat	Epoxy intermediate coat HEMPADUR 47300 / 45880/W / 17634	200 (if applicable 2x100)
Top coat	Polyurethane-topcoat HEMPATHANE 55610 / 55210/4	60
Total	Minimum dry film thickness:	320
It concerns tubular tower inside as well as any steel- and cast parts located inside the nacelle how main gear box, yaw drive units, generator i.a.,C4 long		
		Dry film thickness in [µm]
Priming coat	Epoxy zinc dust primer HEMPADUR 17360	50
Intermediate coat	Epoxy intermediate coat HEMPADUR 47300 / 47140 / 45880/W / 17634	140
Top coat	Polyurethane-topcoat HEMPATHANE 55610 / 55210/4	50
Total	Minimum dry film thickness:	240

3.4 Coating system for stainless steel, hot dip galvanised parts, aluminum

Feature	Description	Value
Surface preparation	<ul style="list-style-type: none"> Hot dip galvanised according to DIN EN ISO 1461 (min. 80µm). All surfaces to be painted must be free of any adhesion- hindering matters, like grease, oil, dirt, flux material, white rust amongst others zinc pit (Hardzinc) and similar irregularities at the surface. This must be eliminated. Sweep blasting with a mineral abrasive, free of any chlorides and iron, until an evenly roughened and flat surface is achieved. Roughness Rz min. 30µm, ISO Comparator (G), Fine – Medium, DIN EN ISO 8503-2. Only ferrite free abrasive used (no glass bead). Carefully dedusting. 	
Coating System for onshore, C4- long (outside atmosphere)		
It concerns any small components and subsystems		
		Dry film thickness in [µm]

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Priming coat	Epoxy primer HEMPADUR 47300 / 47140 / 45880/W / 15553	100
Top coat	Polyurethane-topcoat HEMPATHANE 55610 / 55210/\$	60
Total	Minimum dry film thickness:	160
Coating System for offshore, C5-marine long (outside atmosphere)		
It concerns any small components and subsystems		
		Dry film thickness in [µm]
Priming coat	Epoxy primer HEMPADUR 15553	60
Intermediate coat	Epoxy intermediate coat HEMPADUR 47300 / 47140 / 45880/W (if applicable 2x90 µm for fili- gree parts)	180
Top coat	Polyurethane-topcoat HEMPATHANE 55610 / 55210/4	80
Total	Minimum dry film thickness:	320
<u>Anmerkung</u> Acc. ISO 12944, Part 5 (Issue 2008), hot dip galvanising for C5 long has to be coated with 320µm instead of with 240µm (ISO 12944, Issue 1998).		

3.5 Coating system for galvanised areas

Feature	Description	Value
Surface preparation		
	<ul style="list-style-type: none"> The metallization must applied according the norm and standard of the German organization. Galvanising according DIN EN 22063/ ISO 2063 (min. 100µm). The metallization has to be painted immedately after its application. Any condensation of the metallization before painting must be avoided. The surface must free of grease, oil, dirt and other materials. All contamination are to avoid. 	
Coating System for onshore, C4- long (outside atmosphere)		
It concerns any small components and subsystems		
		Dry film thickness in [µm]
Priming coat	Epoxy primer	100

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	HEMPADUR 47300 / 47140 / 45880/W / 15553	
Top coat	Polyurethane-topcoat HEMPATHANE 55610 / 55210/4)	60
Total	Minimum dry film thickness:	160
Coating System for offshore, C5-marine long (outside atmosphere)		
It concerns any small components and subsystems		
		Dry film thickness in [µm]
Priming coat	Epoxy primer HEMPADUR 47300 / 47200 / 47140 / 45880/W / 15553	2 x 90
Top coat	Polyurethane-topcoat HEMPATHANE 55610 / 55210/4)	60
Total	Minimum dry film thickness:	240
Remarks:		
<ul style="list-style-type: none"> Depending on roughness, thickness and quality of the metallization layer, popping may occur during first painting (due to porosity of the metallization). It is therefore recommended to apply the first layer up to ca. 30 – 40% thinned (flash or mist coat). After 10-20 minutes the full coat can be applied with unthinned paint. 		

3.6 Corrosion-proofing

The corrosion-proofing coating must accure, that a storage outside for min. 6 month is possible without any corrosion-damages. Due to machining surfaces and bore holes, there must be held accuracy.

Rust-proofing must be done according to general standards and guidelines for rust-proofing and transportation to avoid damages during transport or storage.

3.6.1 Protection of contact areas of flanges

The loss of bias tower in the bolted flanges should not exceed 10% according to DIN 18800-7, march 2001.

Protection

Zinc metallization DIN EN ISO 2063 (min. 80 µm). After application the metallization has to be protected by suitable means.

or

epoxy zinc dust according to TL 918 300, page 85, 70µm (e.g. HEMPADUR 87260)

or

alkali zinc silicate according TL 918 300, page 85, 70µm.

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Other paints may also be used after approval (e.g. Interzinc 697, former Redox SC 5115, Fa. AKZO International, surface preparation acc. Product specification sheet).

3.6.2 Protection of metallic clean surfaces

For components with metallic clean surfaces and internal contours of e.g. bearings must be treated with preservatives which allow the component to be stored indoors for at least 12 months without any corrosion damage.

In order to guarantee corrosion protection for at least 1 years, a thin film of VCI 368 is applied to all inside and outside profiles. In addition, the slewing ring is wrapped in VCI stretch foil and sealed in PE foil.

In order to prevent damage to the foils, the slewing ring is packed and fixed in a wooden crate.

As a suitable preservative, for example, can be used:

Cortec VPCI 369

Cortec VPCI 368

3.7 Coating system for Rotor Blade

- Polyurethane based two component system
- Only use Coating Systems (Top Coat, Primer (if needed), Putty, Porefiller, Leading Edge Protection) that are explicitly dedicated for Rotor Blades of Wind Turbines:
 - Makiewicz ALEXIT
 - BASF RELEST
 - Bergolin Rotor Blade Coating
- For Repair Workings there special repair kits from any coating supplier available:
 - For Example BASF RELEST Wind Rep Kit
 - Makiewicz ALEXIT BladeRep
 - Bergoline Rotor Blade Repair Kit
- There is a broad range of coating systems available in the market – depending on the following conditions it is necessary to individually chose the right coating system:
 - Environmental Factors of the location of coating
 - Environmental Factors on the wind turbine site
 - Available tools for coating
 - Knowledge and practice of the coater
- As a result coating has to be chosen in congruence with a coating system supplier
- The specific application and specification of the coating system (f.e. Environmental conditions (temperature, moisture, dust), Curing / drying time, Sanding grain, Wet- and dry film thickness, Roughness of the surface after coating) depends on the coating system – as a result follow the documentation of the coating system

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3.7.1 Application for Coating a raw blade (example ALEXIT System)

1. *Sanding the surface (grain: 220)* re-
removes release agent and activates the surface in order to improve adhesion for following steps
2. *Apply Putty*
creates even and smooth surface
3. *Sanding the surface (grain: 220)* re-
reduces thickness of putty layer and activates the surface in order to improve adhesion for following steps
4. *Apply Porefiller*
fills remaining small pores / pin holes in the surface
5. *Sanding the surface (grain: 220)*
activates the surface in order to improve adhesion for following steps
6. *In case of Leading Edge Protection Coating:*
 - a. *Isolate leading edge*
200 mm from bonding edge onto suction- and pressure side
use foil to cover and on the edges a sponge tape (smooth junction between LEP and topcoat)
 - b. *after step 7:*
 - i. apply 1st Layer of LEP
 - ii. Sanding the surface (grain: 220)
 - iii. Apply 2nd Layer of LEP
 - iv. Sanding the surface (grain: 220)
 - v. Apply 3rd Layer of LEP
7. *In case of Top Coat System with primer:*
 - a. *Apply Primer*
 - b. *Sand surface (Grain 220)*
8. *Apply Top-Coating (200 µm wet layer thickness in case of spray application)*
9. *In case of Leading Edge Protection Tape:* Ap-
ply Leading Edge Protection Tape

3.7.2 Application for Coating after Blade Repair (example ALEXIT System)

1. *In case of damage in the coating:* Re-
move coating by sanding the surface (very evenly!) – use grain: 120
2. *Do step 1-9 of chapter 3.7.1*

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4. References

The technical data which are specified in this document will be extended by references to additional technical documents or drawings. The referenced documents are named via unique file names. They are named in a table below. This document will be updated to change a several modifications. The licensor has the discretionary authority for updates.

For following developments especially for components production the current state of development respectively of the referenced documents the licensor has to be requested.

No.	Document No. W2E, Title	Document class	Date of issue	Notes
[1]	ISO 9000 Qualitätsmanagement-system	public		Guidelines for quality management
[2]	Germanischer Lloyd: Regulation for the Certification of Wind Energy Conversion Systems	public	2003	TBD Accountability of customer
[3]	General terms between supplier and seller	confidential		
[4]	DIN EN ISO 12944 Paints and varnishes – Corrosion protection of steel structures by protective paint systems.	public		
[5]	DIN EN ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.	public		
[6]	DIN 18364 (VOB) Contract procedures for buildings works – Part C: General technical specifications for buildings works; Works for protection of steel and aluminium structures.	public		
[7]	DIN V 18800-7 Steel structures – Part 7: Execution and constructor's qualification.	public		
[8]	DIN EN ISO 2063 Thermal spraying – Metallic and other inorganic coatings – zinc, aluminum and their alloys.	public		
[9]	ISO 8501 <i>Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness.</i>	public		

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[10]	ISO 8502 <i>Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness.</i>	public		
[11]	ISO 8503 <i>Preparation of steel substrates before application of paints and related products – Surface roughness characteristics of blast – cleaned steel substrates.</i>	public		
[12]	ISO 4628 <i>Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance.</i>	public		
[13]	AGI Arbeitsblatt Feuerverzinken - Duplexsystem	public		
[14]	DIN EN ISO 2808 <i>Paints and varnishes – determination of film thickness</i>	public		
[15]	ISO 19840 <i>Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces.</i>	public		
[16]	Norsok M 501 <i>Surface preparation and protective coating.</i>	public		
[17]	W9902-G029-100-DASH-304-LV6-001	public	24.11.2009	Safety data sheet TECTYL 506-EH
[18]	W9902-G029-100-DASH-304-LV6-002	public	08.08.2006	Product information TECTYL 506-EH